

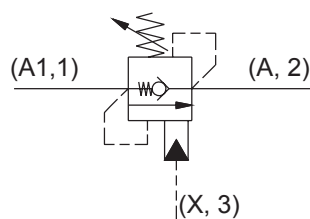
## **COUNTERBALANCE VALVES**



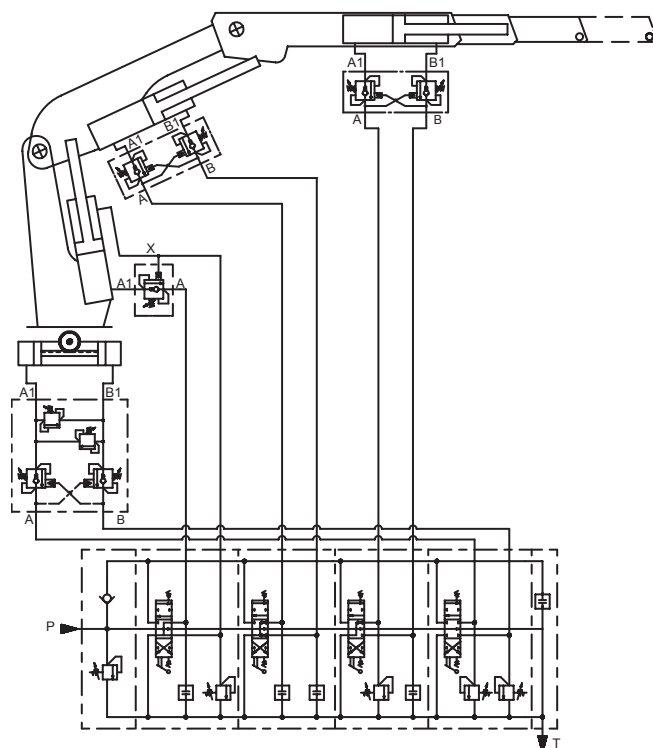
**COUNTERBALANCE VALVES**

**INTRODUCTION**

Counterbalance valves are hydraulic valves designed specifically to hold and control negative or gravitational loads. They are meant to serve all those applications that involve the control of suspended loads, such as mechanical joints, lifting applications, extensible movable bridge, winches, etc... Counterbalance valves main functionalities are lowering velocity control and stationary load holding. Counterbalance valves hydraulic symbol is similar to an integrated micro-circuit, in which 3 characteristic components can be identified:



- A uni-directional valve, which allow a free feeding to the hydraulic actuator and lock load in the required position.
- A pressure relief valve, which, thanks to its specific configuration, holds the loads acting on hydraulic actuators (for instance, cylinders or motors) and limits max pressurization, allowing also stress control, where needed.
- A pilot piston, which opens the pressure relief valve, thanks to connection to hydraulic energy source.



*Fig.2 Example of counterbalance valve application*

Generally, counterbalance valves are installed directly on cylinders or hydraulic actuators (ex. Port A1-1).

**COUNTERBALANCE VALVES**

That guarantees load control and holding even in case of rupture or external leakage of the hoses connecting valve and setting device (directional control valve). Picture nr. 2 shows an example of truck crane hydraulic scheme, which is a typical application for counterbalance valves.

**WORKING PRINCIPLE**

Thanks to the uni-directional valves, oil flow regulated by the directional control valve comes inside the cylinder facing minimum resistance.

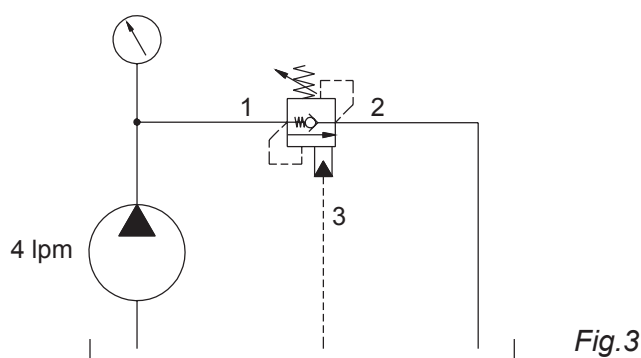
When directional spools are in neutral position, sealing devices are in rest position, locking connection between hydraulic actuator and directional control valve. Thanks to mechanical sealing obtained through grinded sealing point, it's possible to avoid leakage through the spools of uni-directional valve. Counterbalance valves, in fact, are able to close with very small leakage (<10 drops/min). Since there are no dents nor saturation effects (possible even in case of clean oil), a perfect sealing will take place in a few minutes.

Pump Connection to pilot line (X-3)– consequence of directional spool change-over– determines the progressive opening of the counterbalance valves, up to the balance satisfying the flows continuity equation. That guarantees the absence of cavitations and also the control of dragged loads lowering velocity.

**SETTING**

Counterbalance valves setting corresponds to the opening pressure of pressure relief section. This pressure determines the max load which counterbalance valve is able to hold.

Usually the setting pressure value must be at least 1.3 times the max load induced pressure to hold. That tolerance allows induced loads safe holding.



**Standard setting pressure (Pt)** of counterbalance valves corresponds to pressure on port (1), while the valve is crossed by a 4l/min flow (picture 3).

**es. Pt: 350 bar @ 4 l/min**

In particular cases, and generally upon customers' request, the pressure can be set considering the initial opening value, corresponding almost to 20 ml/min. flow.

**es. Pt: 350 bar @ 20 ml/min**



**COUNTERBALANCE VALVES**

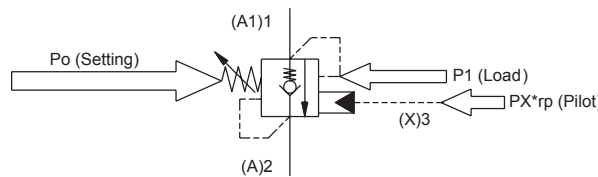
**PILOT RATIO**

As mentioned before, counterbalance valves are characterized by a pilot area on which pressure coming from the actuator's feeding line acts. Such pressure, together with the pressure due to the load, moves pilot piston, progressively contrasting the force generated by the setting spring.

Hence the combined action of the two pressures is connected to the ratio between the pushing areas on which they act. This ratio is known as "Pilot Ratio" (pr), and it is the basic parameter for any counterbalance valve.

Pilot Ratio (pr) is defined as the geometrical ratio between the area on which the load acts (port 1) and the pilot area (port 3). Thanks to this parameter, it is possible to calculate the values of pilot pressures first opening (Px):

$$P_x = (P_t - P_1) / r_p$$



According to the Pilot Ratio, counterbalance valves can be divided in 2 types:

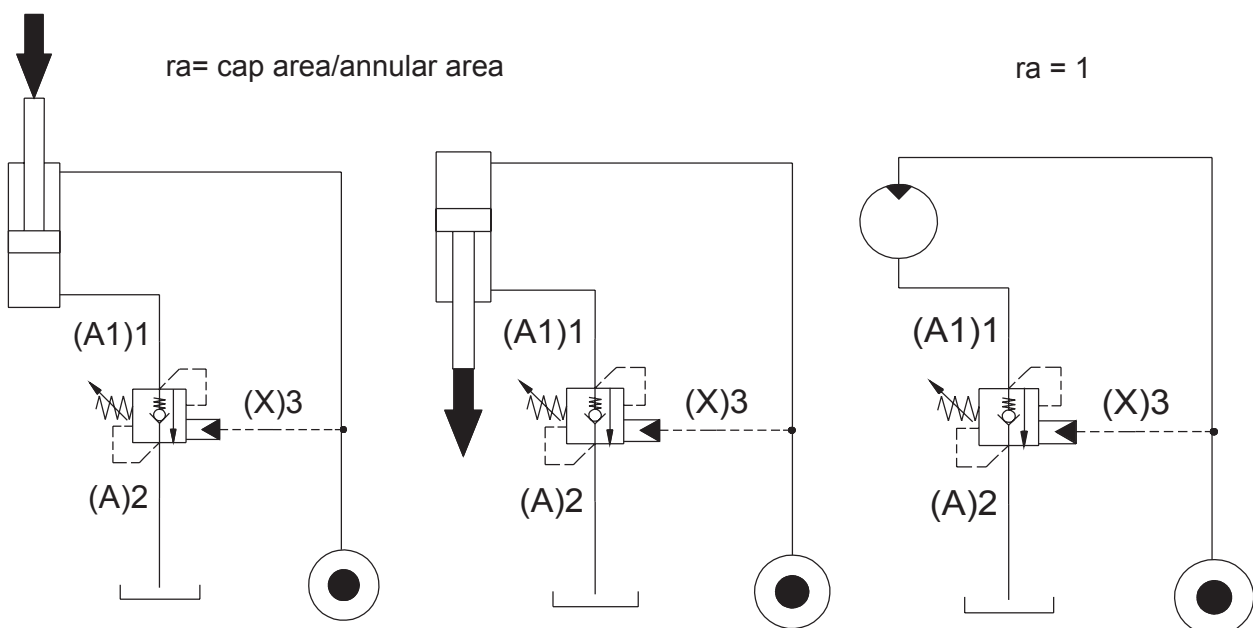
**High Pilot Ratio (>6:1):** suitable for those applications where the loads are constant (for instance, hydraulic motors) and very stable, where low pilot pressures are demanded in favour of speed and energy savings.

**Low Pilot Ratio (<5:1):** suitable for those applications where loads can vary (for instance, trucks cranes) and for those mechanical structures are not stable, where more control and more stability are needed, an higher pilot pressure is required.

When counterbalance valves are installed on hydraulic actuators, to determine the correct value of pilot pressure it is necessary to introduce in the calculation the ratio between the areas of the actuator itself.

$$P_x = (P_t - P_1) / (r_p + r_a)$$

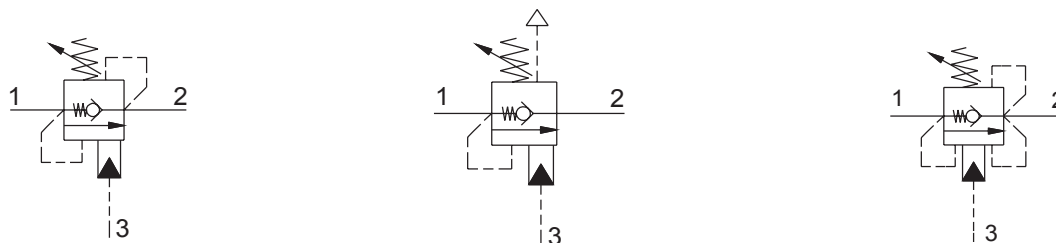
ra: ratio between the areas of the hydraulic actuator



**COUNTERBALANCE VALVES**

**COMPENSATION**

Because of coupling counterbalance valves with directional control valves, considering the type of spool to use is needed. When the counterbalance valves are in charge of the pressure relief function, it's essential to make a distinction between "closed-centre" spool applications and "open-centre" spool application. Generally, when "closed-centre" spools are installed, it's necessary to use compensated counterbalance valves: since these valves are insensitive to back-pressure on return line (A-2), their pressure setting won't change.



Two examples of compensated valves application are regenerative circuits and circuits in which draining of eventual pressure peaks must be relieved in series by the anti-shock valves installed inside the directional control valve.

In case of "open-centre" directional spool application, not-compensated valves are compulsory, in which the spring is connected to the return line (A-2).

In **Not-Compensated (N)** type valves, back-pressure affects both pressure setting and pilot pressure. In these valves, the return line is directly connected to the spring. Valves in which adjustable spring is connected to return line are not compensated ones.

Main use: open-centre spool application.

In **Fully-Compensated (C)** type valves, back-pressure does not affect neither pressure setting nor pilot pressure. Belong to this type the valves in which the adjustable spring is separated from return line (A-2) and is connected to a draining line or is air-vented.

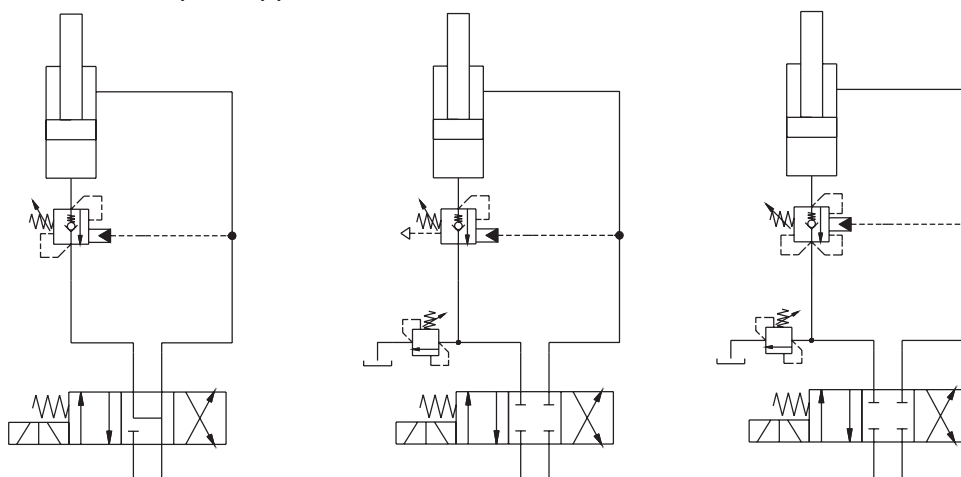
In these valves, back-pressure (A-2) is balanced, so it won't find any area to carry out its force, so that both setting and pilot pressures are independent from pressure on return line (A).

Main use: closed-centre spool applications, regenerative circuits.

In **Relief-Compensated (S)** valves, only pressure setting is independent from back-pressure, while pilot pressure is affected by back-pressures, which sometimes can be helpful in stabilizing the circuit.

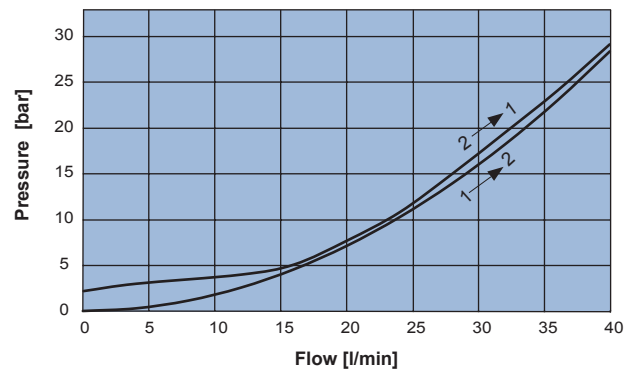
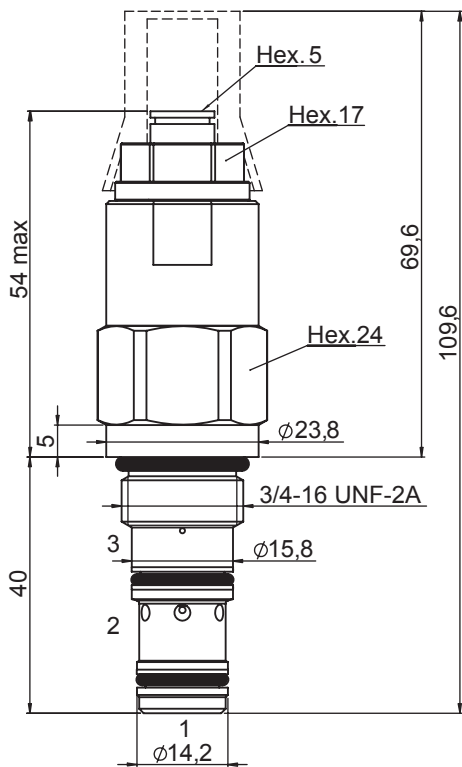
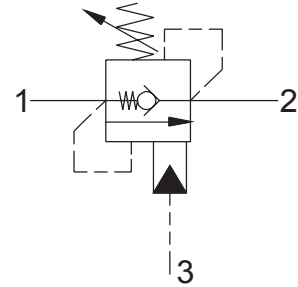
To this kind of valves belong all the valves in which only the area subject to the load (A1-1) is balanced.

Main use: closed-centre spool applications.



**NOT COMPENSATED COUNTERBALANCE VALVE**

- Flow. . . . . **40 l/min**
- Max working pressure. . . . . **350 bar**
- Compensation. . . . . **Not compensated**
- Cartridge tightening torque. . . . . **40-45 Nm**
- Seal lock nut tightening torque. . . . . **15-20 Nm**
- Weight. . . . . **0,2 Kg**
- Tamper proof cap . . . . . **cod. 4029250280**
- To be ordered separately only for version 0-prearranged**
- Cavity . . . . . **C321000** page 219
- Body single cavity. . . . . **172212** page 188
- Body double cavity . . . . . **176212** page 189



**Note**  
 -Setting: 1,3 times the maximum load induced pressure.  
 -The back pressure (2) may affect the relief function (for circuits with back pressure use 0612.1 or 0612.2).

**Ordering code**

**0 6 1 2 0**       **0 0**

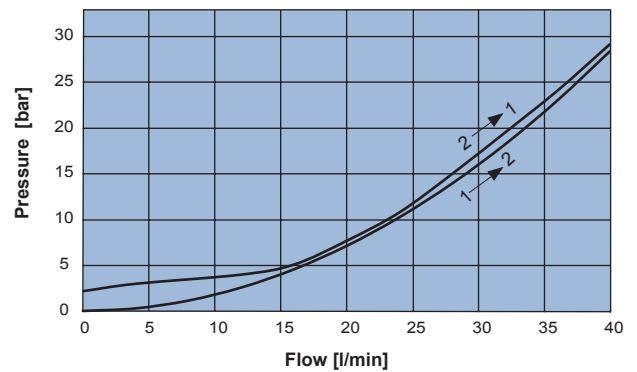
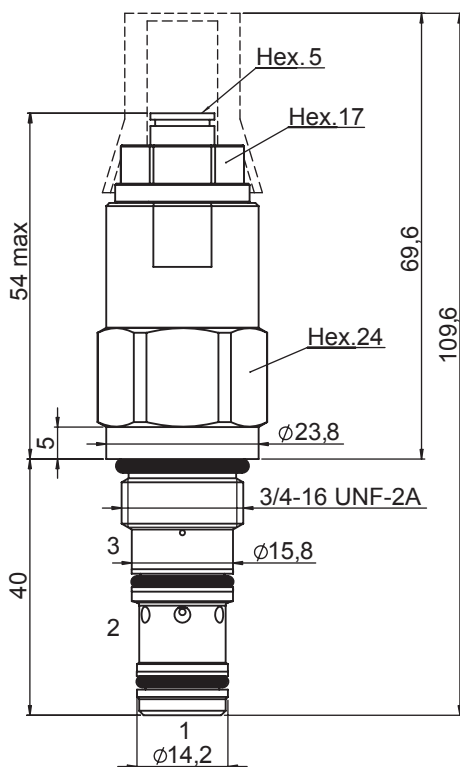
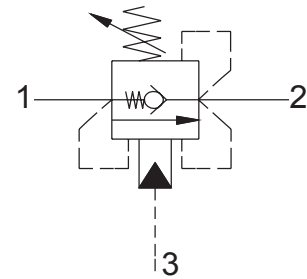
| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        | <b>2</b>  | <b>3</b>  |
|--------------------------------|-----------|-----------|
| Setting range [bar]            | 120 - 210 | 170 - 350 |
| Pressure Increase [bar/turn]   | 35        | 60        |
| Standard setting 4 l/min [bar] | 210       | 350       |

| TAMPER PROOF OPTION |          |
|---------------------|----------|
| PRE-ARRANGED        | <b>0</b> |
| NOT PRE-ARRANGED    | <b>2</b> |

**RELIEF COMPENSATED COUNTERBALANCE VALVE**

- Flow. . . . . **40 l/min**
- Max working pressure. . . . . **350 bar**
- Compensation. . . . . **Relief compensated**
- Cartridge tightening torque. . . . . **40-45 Nm**
- Seal lock nut tightening torque. . . . . **15-20 Nm**
- Weight. . . . . **0,2 Kg**
- Tamper proof cap . . . . . **cod. 4029250280**
- To be ordered separately only for version 0-prearranged**
- Cavity. . . . . **C321000** page 219
- Body single cavity. . . . . **172212** page 188
- Body double cavity . . . . . **176212** page 189



**Note**  
-Setting: 1,3 times the maximum load induced pressure.

**Ordering code**

**0 6 1 2 2**    **0 0**

| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

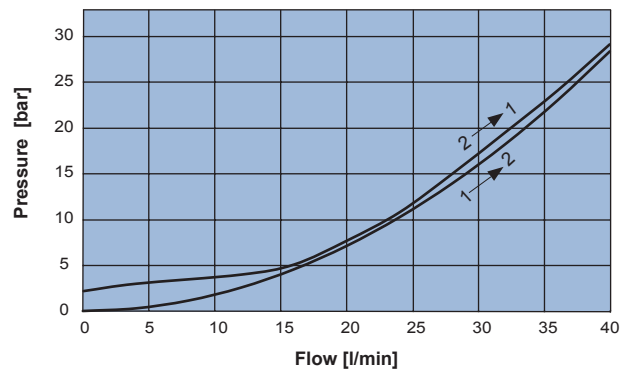
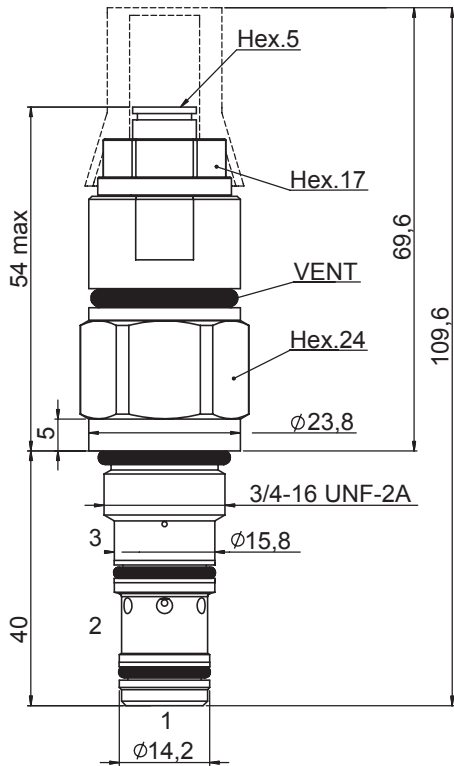
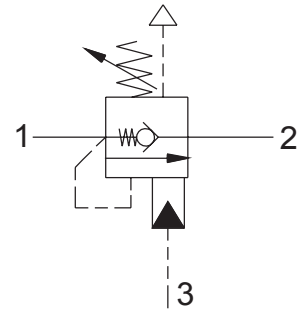
| SPRINGS                        | <b>2</b>  | <b>3</b>  |
|--------------------------------|-----------|-----------|
| Setting range [bar]            | 120 - 210 | 170 - 350 |
| Pressure Increase [bar/turn]   | 35        | 60        |
| Standard setting 4 l/min [bar] | 210       | 350       |

| TAMPER PROOF OPTION |          |
|---------------------|----------|
| PRE-ARRANGED        | <b>0</b> |
| NOT PRE-ARRANGED    | <b>2</b> |



**FULLY COMPENSATED COUNTERBALANCE VALVE**

- Flow. . . . . **40 l/min**
- Max working pressure. . . . . **350 bar**
- Compensation. . . . . **Fully compensated**
- Cartridge tightening torque. . . . . **40-45 Nm**
- Seal lock nut tightening torque. . . . . **15-20 Nm**
- Weight. . . . . **0,2 Kg**
- Tamper proof cap. . . . . **cod. 4029250280**
- To be ordered separately only for version 0-prearranged**
- Cavity . . . . . **C321000** page **219**
- Body single cavity. . . . . **172212** page **188**
- Body double cavity . . . . . **176212** page **189**



**Note**  
-Setting: 1,3 times the maximum load induced pressure.  
-To be used only with A/B closed center spools.

**Ordering code**

**0 6 1 2 1**    **0 0**

| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

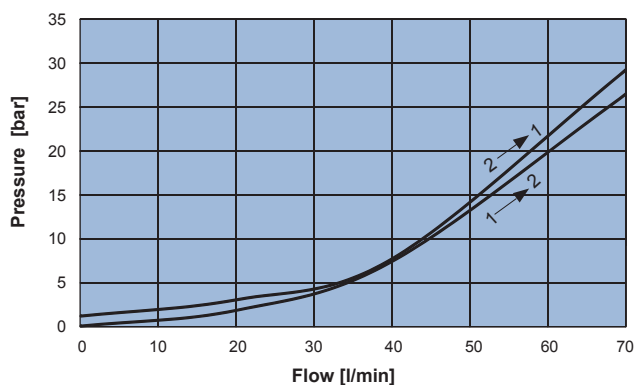
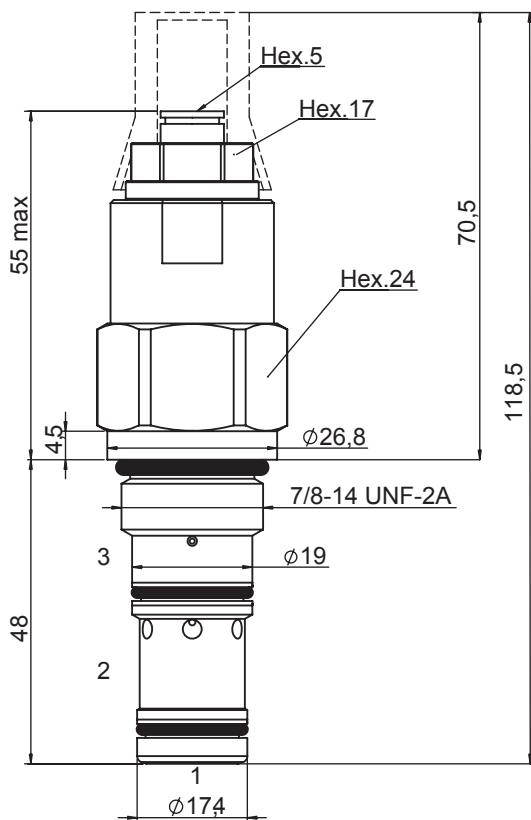
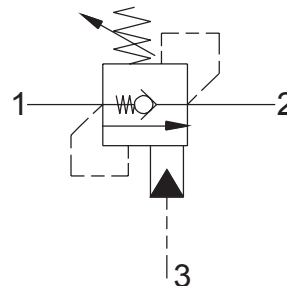
| SPRINGS                        | <b>2</b>  | <b>3</b>  |
|--------------------------------|-----------|-----------|
| Setting range [bar]            | 120 - 210 | 170 - 350 |
| Pressure Increase [bar/turn]   | 35        | 60        |
| Standard setting 4 l/min [bar] | 210       | 350       |

| TAMPER PROOF OPTION |          |
|---------------------|----------|
| PRE-ARRANGED        | <b>0</b> |
| NOT PRE-ARRANGED    | <b>2</b> |



**NOT COMPENSATED COUNTERBALANCE VALVE**

- Flow . . . . . **70 l/min**
- Max working pressure . . . . . **350 bar**
- Compensation . . . . . **Not compensated**
- Cartridge tightening torque . . . . . **50-55 Nm**
- Seal lock nut tightening torque . . . . . **15-20 Nm**
- Weight . . . . . **0,3 Kg**
- Tamper proof cap . . . . . **cod. 4029250280**
- To be ordered separately only for version 0-predisposed**
- Cavity . . . . . **C331000** page **221**
- Body single cavity . . . . . **172312** page **193**
- Body double cavity . . . . . **176312** page **194**



**Note**  
 -Setting: 1,3 times the maximum load induced pressure.  
 -The back pressure (2) may affect the relief function (for circuits with back pressure use 0613.1 or 0613.2).

**Ordering code**

**0 6 1 3 0**       **0 0**

| PILOT RATIO |              |
|-------------|--------------|
| <b>3</b>    | <b>3,5:1</b> |
| <b>8</b>    | <b>8:1</b>   |

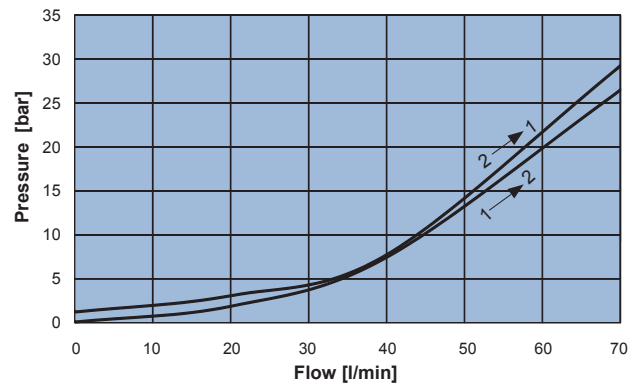
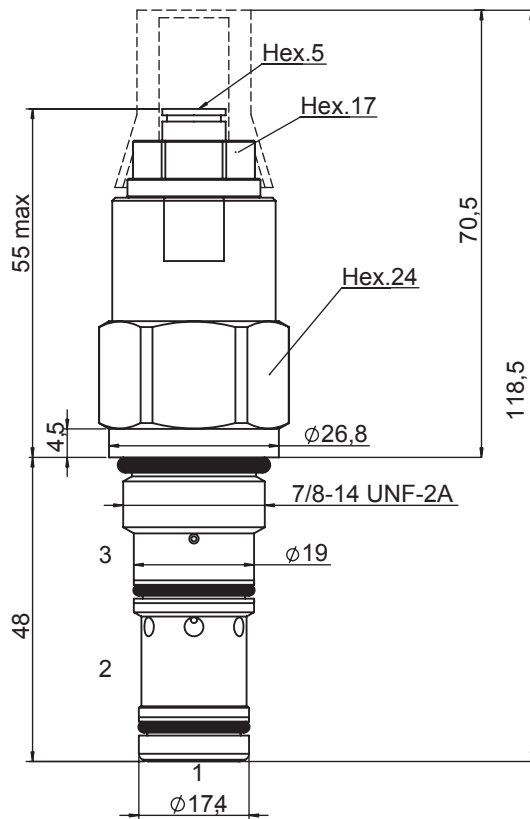
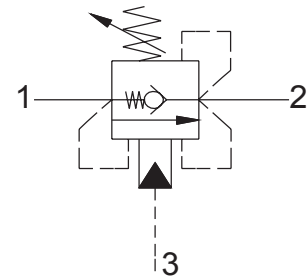
| SPRINGS                        | <b>2</b> | <b>3</b>  |
|--------------------------------|----------|-----------|
| Setting range [bar]            | 80 - 210 | 180 - 350 |
| Pressure Increase [bar/turn]   | 37       | 47        |
| Standard setting 4 l/min [bar] | 210      | 350       |

| TAMPER PROOF OPTION |          |
|---------------------|----------|
| PRE-ARRANGED        | <b>0</b> |
| NOT PRE-ARRANGED    | <b>2</b> |



**RELIEF COMPENSATED COUNTERBALANCE VALVE**

- Flow.....70 l/min
- Max working pressure.....350 bar
- Compensation.....Relief compensated
- Cartridge tightening torque.....50-55 Nm
- Seal lock nut tightening torque.....15-20 Nm
- Weight.....0,3 Kg
- Tamper proof cap.....cod. 4029250280
- To be ordered separately only for version 0-prearranged**
- Cavity.....C331000 page 221
- Body single cavity.....172312 page 193
- Body double cavity.....176312 page 194



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.

**Ordering code**

0 6 1 3 2       0 0

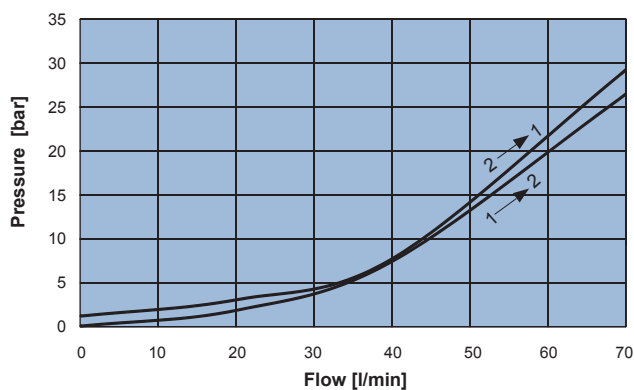
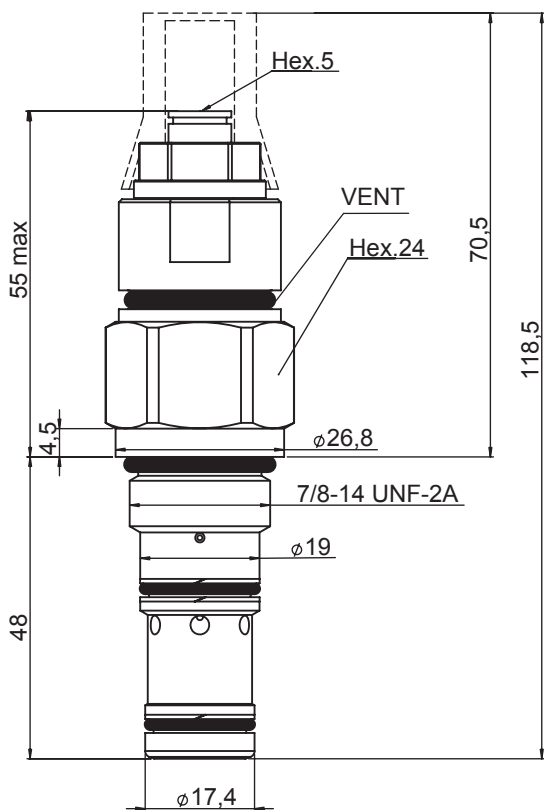
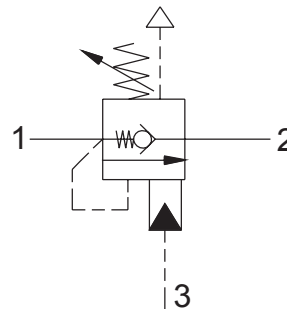
| PILOT RATIO |       |
|-------------|-------|
| 3           | 3,5:1 |

| SPRINGS                        | 2        | 3         |
|--------------------------------|----------|-----------|
| Setting range [bar]            | 80 - 210 | 180 - 350 |
| Pressure Increase [bar/turn]   | 37       | 47        |
| Standard setting 4 l/min [bar] | 210      | 350       |

| TAMPER PROOF OPTION |   |
|---------------------|---|
| PRE-ARRANGED        | 0 |
| NOT PRE-ARRANGED    | 2 |

**FULLY COMPENSATED COUNTERBALANCE VALVE**

- Flow.....70 l/min
- Max working pressure.....350 bar
- Compensation.....Fully compensated
- Cartridge tightening torque.....50-55 Nm
- Seal lock nut tightening torque.....15-20 Nm
- Weight.....0,3 Kg
- Tamper proof cap.....cod. 4029250280
- To be ordered separately only for version 0-predisposed**
- Cavity.....C331000 page 221
- Body single cavity.....172312 page 193
- Body double cavity.....176312 page 194



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.  
-To be used only with A/B closed center spools.

**Ordering code**

0 6 1 3 1       0 0

| PILOT RATIO |       |
|-------------|-------|
| 3           | 3,5:1 |

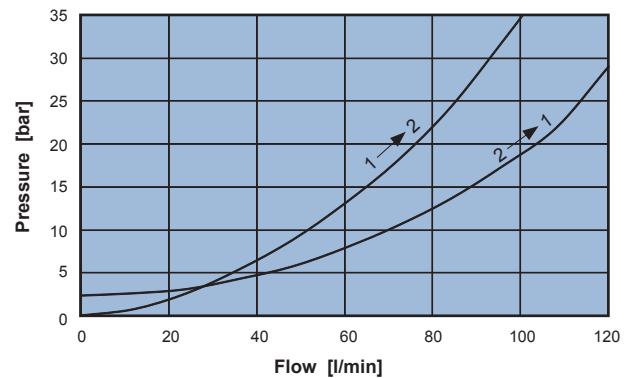
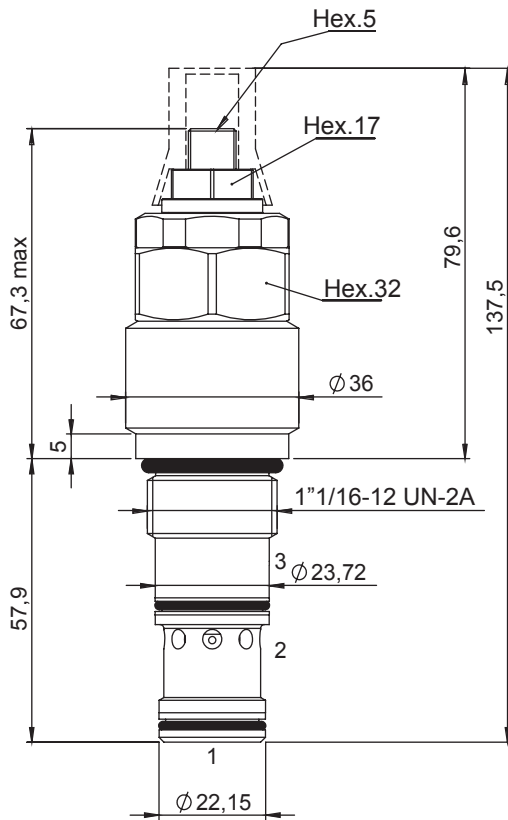
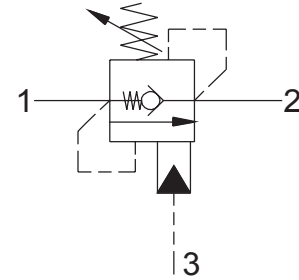
| SPRINGS                        | 2        | 3         |
|--------------------------------|----------|-----------|
| Setting range [bar]            | 80 - 210 | 180 - 350 |
| Pressure Increase [bar/turn]   | 37       | 47        |
| Standard setting 4 l/min [bar] | 210      | 350       |

| TAMPER PROOF OPTION |   |
|---------------------|---|
| PRE-ARRANGED        | 0 |
| NOT PRE-ARRANGED    | 2 |



**NOT COMPENSATED COUNTERBALANCE VALVE**

- Flow..... **100 l/min**
- Max working pressure..... **410 bar**
- Compensation..... **Not compensated**
- Cartridge tightening torque..... **60 Nm**
- Seal lock nut tightening torque..... **15-20 Nm**
- Weight..... **0,7 Kg**
- Tamper proof cap..... **cod. 4029250280**
- Cavity..... **C341000** page **223**
- Body single cavity..... **172412** page **199**
- Body double cavity..... **176412** page **200**



**Note:**  
 -Setting: 1,3 times the maximum load induced pressure.  
 -The back pressure (2) may affect the relief function (for circuits with back pressure use 0614.2 or 0.614.1).

**Ordering code**

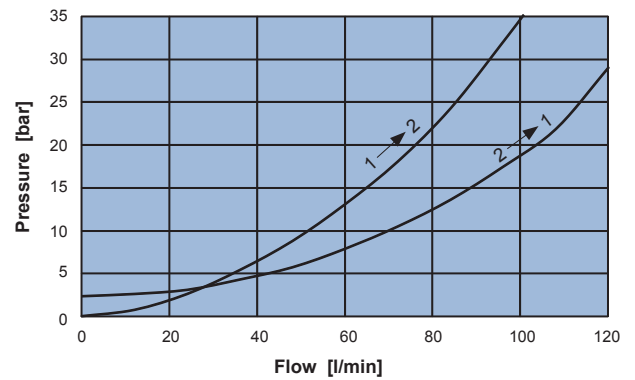
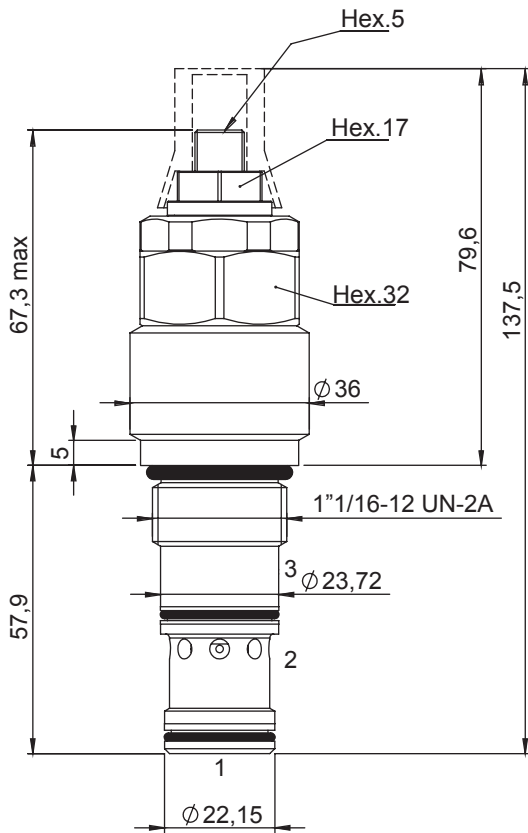
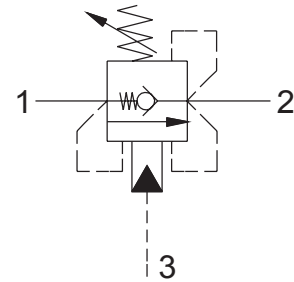
**0 6 1 4 0**     **0 0 0**

| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        |           |
|--------------------------------|-----------|
|                                | <b>4</b>  |
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |

**RELIEF COMPENSATED COUNTERBALANCE VALVE**

- Flow..... **100 l/min**
- Max working pressure..... **410 bar**
- Compensation..... **Relief compensated**
- Cartridge tightening torque..... **60 Nm**
- Seal lock nut tightening torque..... **15-20 Nm**
- Weight..... **0,7 Kg**
- Tamper proof cap..... **cod. 4029250280**
- Cavity..... **C341000** page **223**
- Body single cavity..... **172412** page **199**
- Body double cavity..... **176412** page **200**



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.

**Ordering code**

**0 6 1 4 2**     **0 0 0**

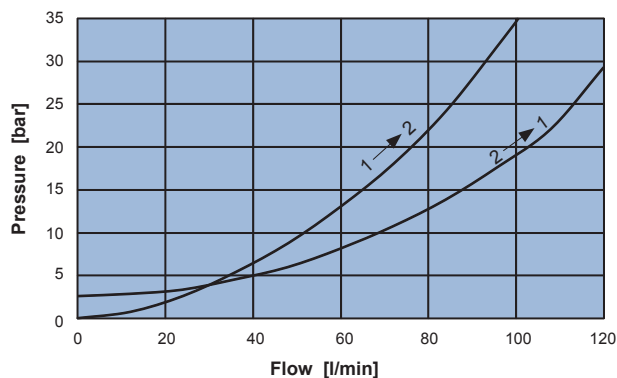
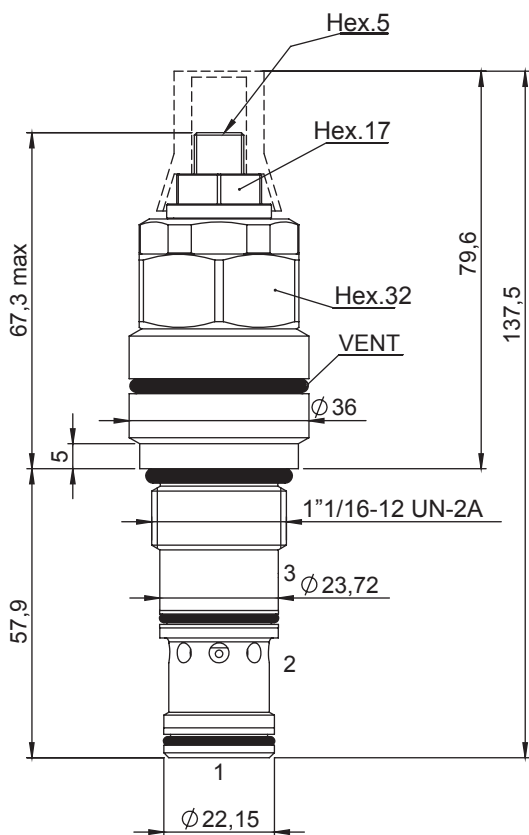
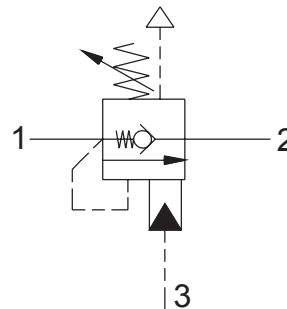
| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        |           |
|--------------------------------|-----------|
| <b>4</b>                       |           |
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |



**FULLY COMPENSATED COUNTERBALANCE VALVE**

- Flow..... **100 l/min**
- Max working pressure..... **410 bar**
- Compensation..... **Fully compensated**
- Cartridge tightening torque..... **60 Nm**
- Seal lock nut tightening torque..... **15-20 Nm**
- Weight..... **0,7 Kg**
- Tamper proof cap..... **cod. 4029250280**
- Cavity..... **C341000** page **223**
- Body single cavity..... **172412** page **199**
- Body double cavity..... **176412** page **200**



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.  
-To be used only with A/B closed center spools.

**Ordering code**

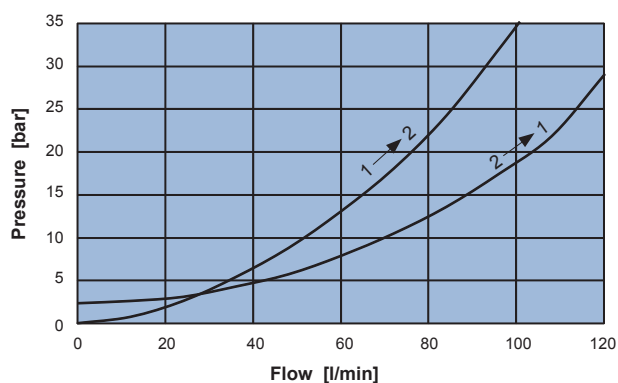
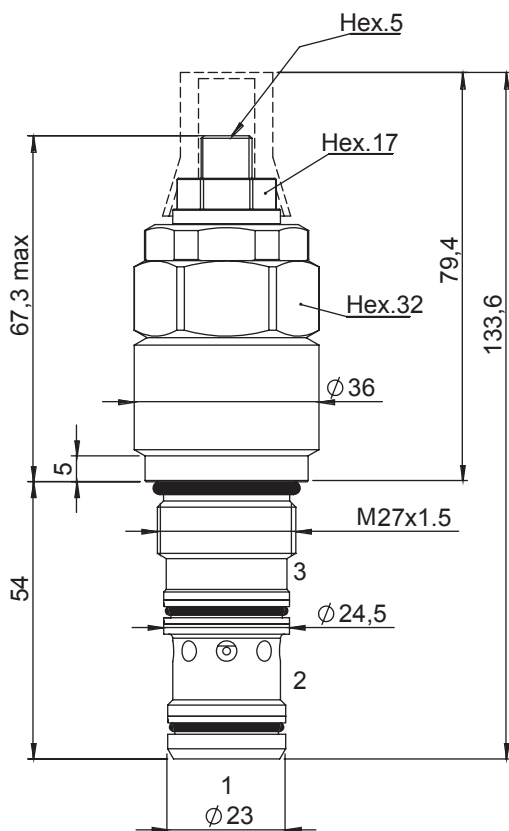
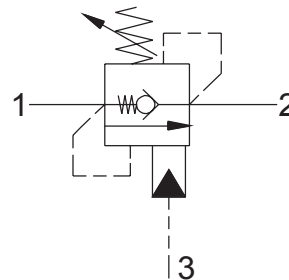
**0 6 1 4 1**     **0 0 0**

| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        | <b>4</b>  |
|--------------------------------|-----------|
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |

**NOT COMPENSATED COUNTERBALANCE VALVE**

- Flow.....100 l/min
- Max working pressure.....410 bar
- Compensation.....Not compensated
- Cartridge tightening torque.....60 Nm
- Seal lock nut tightening torque.....15-20 Nm
- Weight.....0,7 Kg
- Tamper proof cap.....cod. 4029250280
- Cavity.....M340000 page 234



**Note:**  
 -Setting: 1,3 times the maximum load induced pressure.  
 -The back pressure (2) may affect the relief function (for circuits with back pressure use 0.6441 o 0.6442).

**Ordering code**

0 6 4 4 0     0 0 0

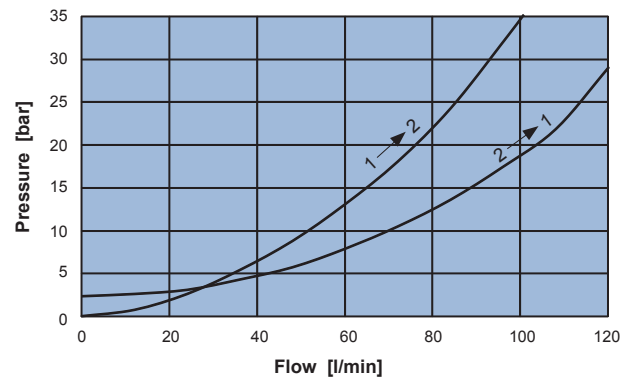
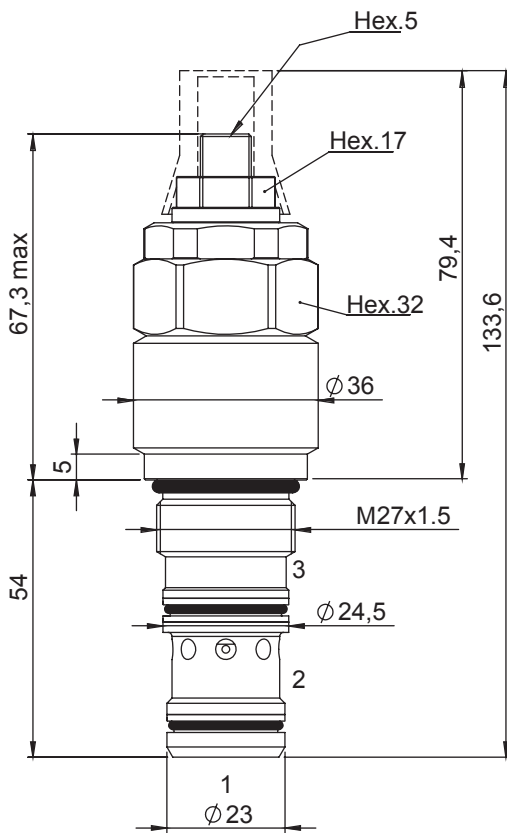
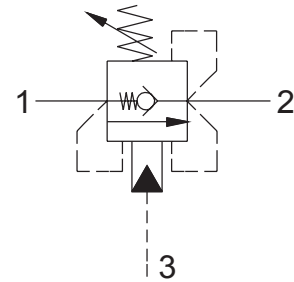
| PILOT RATIO |     |
|-------------|-----|
| 5           | 5:1 |

| SPRINGS                        | 4         |
|--------------------------------|-----------|
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |



**RELIEF COMPENSATED COUNTERBALANCE VALVE**

- Flow ..... **100 l/min**
- Max working pressure ..... **410 bar**
- Compensation ..... **Relief compensated**
- Cartridge tightening torque ..... **.60 Nm**
- Seal lock nut tightening torque ..... **15-20 Nm**
- Weight ..... **0,7 Kg**
- Tamper proof cap ..... **cod. 4029250280**
- Cavity ..... **M340000** page 234



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.

**Ordering code**

**0 6 4 4 2**     **0 0 0**

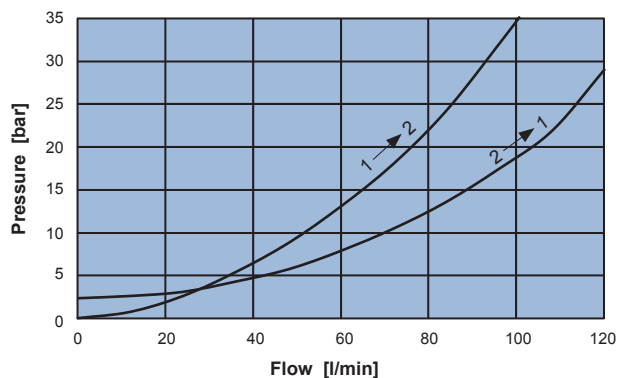
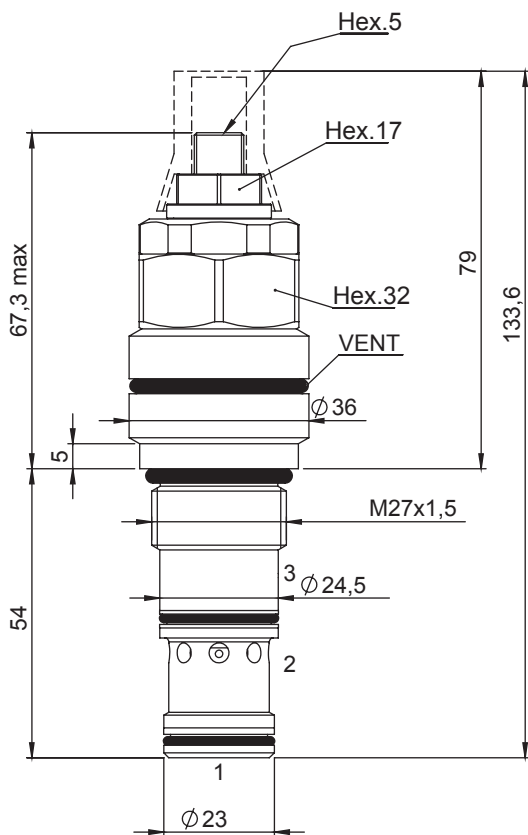
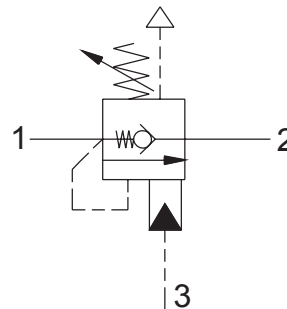
| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        | <b>4</b>  |
|--------------------------------|-----------|
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |



**FULLY COMPENSATED COUNTERBALANCE VALVE**

- Flow ..... **100 l/min**
- Max working pressure ..... **410 bar**
- Compensation ..... **Fully compensated**
- Cartridge tightening torque ..... **.60 Nm**
- Seal lock nut tightening torque ..... **15-20 Nm**
- Weight ..... **0,7 Kg**
- Tamper proof cap ..... **cod. 4029250280**
- Cavity ..... **M340000** page 234



**Note:**  
-Setting: 1,3 times the maximum load induced pressure.  
-To be used only with A/B closed center spools.

**Ordering code**

**0 6 4 4 1**     **0 0 0**

| PILOT RATIO |            |
|-------------|------------|
| <b>5</b>    | <b>5:1</b> |

| SPRINGS                        | <b>4</b>  |
|--------------------------------|-----------|
| Setting range [bar]            | 230 - 410 |
| Pressure Increase [bar/turn]   | 34        |
| Standard setting 4 l/min [bar] | 350       |

